may fall a broad scope of from 0.5 nanometers to 4 nanometers. Since Hs is smaller with the reduction in the free layer thickness, it is desirable that the current magnetic field Hcu is smaller. In this Example, the nonmagnetic high-conductivity layer is of Cu. Apart from this, when the layer is of any other metal material or of a laminate film, it thickness could be in terms of the thickness of the Cu layer. For example, where the nonmagnetic high-conductivity layer is a laminate film of 1.5 nm Ru/1 nm Cu, the specific resistivity of Ru therein is 30 μΩcm and that of Cu is 10 μΩcm, as measured through experiments. Therefore, the thickness of the laminate film will correspond to the Cu layer thickness of (1.5 nm x 10 μΩcm/30 μΩcm) + 1 nm = 1.5 nm.

In the same manner, for other metallic laminate films for the nonmagnetic high-conductivity layer, the current flow ratio could be obtained on the basis of the experimental data of specific resistivity of the constituent metals, 10 μΩcm for Cu, 30 μΩcm for Ru, 10 μΩcm for Au, 10 μΩcm for Ag, 20 μΩcm for Ir, 70 μΩcm for Re, 20 μΩcm for Rh, 40 μΩcm for Pt, 40 μΩcm for Pd, 12 μΩcm for Al, and 30 μΩcm for Os. Where the nonmagnetic high-conductivity layer is of an alloy, its thickness could be also in terms of the Cu layer thickness, based on the specific resistance of the constituent elements as above, for which the specific resistance data may be proportionally partitioned according to the elemental

composition.

As so mentioned hereinabove for the Comparative Cases, the specific resistance of the metals constituting the nonmagnetic high-conductivity layer will vary depending on the material with which the layer is contacted. However, the material to be contacted with the nonmagnetic high-conductivity layer does not differ so much in different spin valve films. Therefore, the suitable range of the thickness of the nonmagnetic high-conductivity layer could be determined on the basis of the data of the specific resistance of the metals constituting the layer.

As in the formula (1-5), Hcu depends on the current flow ratio of the upper and lower layers above and below the free layer. Therefore, for reducing Hcu, it is desirable that the thickness of the spacer layer as positioned at the side opposite to the side of the nonmagnetic high-conductivity layer is as small as possible. This meets the requirement for the spin filter effect on MR ratio, which will be mentioned hereunder. Concretely, it is desirable that the spacer film thickness falls between 1.5 nanometers and 2.5 nanometers or so.

The nonmagnetic high-conductivity layer also functions as the layer exhibiting the spin filter effect on MR ratio with the reduction in the current magnetic field Hcu. For its effect, the suitable range of the thickness of the layer will be limited in some degree. For example, where conductive

electrons that move from the pinned layer to the free layer are taken into consideration, it is desirable that the mean free path for the electrons is large, depending on the magnetization direction of the free layer as to whether it is parallel or antiparallel to the magnetization direction of the pinned layer. Therefore, it is desirable that the spacer film is thinner, not depending on spin-up or spin-down. To avoid increasing Hin, the preferred range of the spacer thickness falls between 1.5 nanometers and 2.5 nanometers.

It is also desirable that the free layer thickness is larger than the mean free path for down spin but is much smaller than that for up spin. For example, since the free mean path for down spin of NiFe is around 1.1 nanometers, it is the best that the NiFe thickness falls between 1 nanometers and 4.5 nanometers or so, and that the CoFe thickness falls between 1 nanometers and 3 nanometers or so. The most preferred range of the high-conductivity layer thickness varies, depending on the pinned layer thickness, the spacer thickness and the free layer thickness. With the spacer layer thickness being smaller, and with the free layer thickness being smaller, the thickness of the high-conductivity layer for MR ratio peak is larger. For example, where the thickness of the pinned layer of CoFe is 2.5 nanometers, that of the spacer of Cu is 2 nanometers and that of the free layer of CoFe is 2 nanometers, the high-conductivity layer of Cu having a thickness of around